

What is claimed is:

1 1. A halftoning method of converting a
2 multilevel input image into a binary image, comprising
3 the steps of:

4 (a) calculating the multilevel value of a given
5 noteworthy pixel of the multilevel input image, as an
6 estimated value of the noteworthy pixel, based on the
7 multilevel values of pixels other than the noteworthy
8 pixel; and

9 (b) converting the estimated multilevel value
10 of the noteworthy pixel into a binary value.

1 2. A halftoning method according to claim 1,
2 wherein in said calculating step (a), the estimated
3 value of the noteworthy pixel is calculated based on
4 the multilevel values of pixels in a predetermined area
5 that is a predetermined distance apart from the
6 noteworthy pixel.

1 3. A halftoning method according to claim 2,
2 wherein in said calculating step (a), the estimated
3 value of the noteworthy pixel is calculated using a
4 two-dimensional digital filter for the multilevel
5 pixels in the predetermined area.

1 4. A halftoning method according to claim 3,
2 wherein said digital filter is a two-dimensional
3 digital filter dedicated to profile enhancement.

1 5. A halftoning method according to claim 4,
2 wherein said two-dimensional digital filter dedicated
3 to profile enhancement is a Laplacian filter.

1 6. A halftoning method according to claim 4,
2 wherein said two-dimensional digital filter dedicated
3 to profile enhancement is a Prewitt filter.

1 7. A halftoning method according to claim 1,
2 wherein a simple threshold method is used in said
3 converting in step (b).

1 8. A halftoning method according to claim 1,
2 further comprising the step (c) of diffusing a possible
3 error, which has occurred in binary value with respect
4 to the noteworthy pixel, to multilevel pixels adjacent
5 to the noteworthy pixel by a technique.

1 9. A halftoning method according to claim 8,
2 wherein a possible error, which has occurred in binary
3 value with respect to the noteworthy pixel, is diffused
4 to the pixels based on which the estimated value of
5 the noteworthy pixel is calculated in step (a).

1 10. A halftoning method according to claim 8,
2 further comprising the step (d) of changing the
3 technique of said error diffusing to another technique
4 in accordance with a predetermined manner as the
5 scanning of the pixels of the multilevel input image
6 progresses.

1 11. A halftoning method according to claim 9,
2 further comprising the step (d) of changing the
3 technique of said error diffusing to another technique
4 in accordance with a predetermined manner as the
5 scanning of the pixels of the multilevel input image
6 progresses.

1 12. A halftoning method according to claim 10,
2 further comprising the step (e) of discriminating
3 whether or not the noteworthy pixel is a pixel
4 constituting part of a profile of the multilevel input
5 image,
6 the error diffusion technique being changed from
7 one to another in said technique changing step (d) if
8 the result of said discriminating is positive.

1 13. A halftoning method according to claim 11,
2 further comprising the step (e) of discriminating
3 whether or not the noteworthy pixel is a pixel
4 constituting part of a profile of the multilevel input

5 image,
6 the error diffusion technique being changed from
7 one to another in said technique changing step (d) if
8 the result of said discriminating is positive.

1 14. A halftoning method according to claim 12,
2 further comprising the step (f) of detecting the
3 direction in which the profile of the multilevel input
4 image extends with respect to the noteworthy pixel,
5 values according to the occurred error being
6 added to the values of unscanned pixels along the
7 detected direction of the profile as an exceptional
8 process, in said error diffusing step (c) if the result
9 of said discriminating is positive in step (e).

1 15. A halftoning method according to claim 13,
2 further comprising the step (f) of detecting the
3 direction in which the profile of the multilevel input
4 image extends with respect to the noteworthy pixel,
5 values according to the occurred error being
6 added to the values of unscanned pixels along the
7 detected direction of the profile as an exceptional
8 process, in said error diffusing step (c) if the result
9 of said discriminating is positive in step (e).

1 16. A halftoning method according to claim 10,
2 wherein in said technique changing step (d), the error

3 diffusion technique is changed for every pixel of the
4 multilevel input image.

1 17. A halftoning method according to claim 11,
2 wherein in said technique changing step (d), the error
3 diffusion technique is changed for every pixel of the
4 multilevel input image.

1 18. A halftoning method according to claim 16,
2 further comprising the steps of (e) discriminating
3 whether or not the noteworthy pixel is a pixel
4 constituting part of a profile of the multilevel input
5 image, and (f) detecting the direction in which the
6 profile of the multilevel input image extends with
7 respect to the noteworthy pixel,
8 values according to the occurred error being
9 added to the values of unscanned pixels along the
10 detected direction of the profile as an exceptional
11 process, in said error diffusing step (c) if the result
12 of said discriminating is positive in step (e).

1 19. A halftoning method according to claim 17,
2 further comprising the steps of (e) discriminating
3 whether or not the noteworthy pixel is a pixel
4 constituting part of a profile of the multilevel input
5 image, and (f) detecting the direction in which the
6 profile of the multilevel input image extends with

7 respect to the noteworthy pixel,
8 values according to the occurred error being
9 added to the values of unscanned pixels along the
10 detected direction of the profile as an exceptional
11 process, in said error diffusing step (c) if the result
12 of said discriminating is positive in step (e).

1 20. A halftoning method according to claim 12,
2 wherein said profile discriminating is carried out by
3 calculating a profile value of the noteworthy pixel
4 based on both the multilevel value of the noteworthy
5 pixel and those of the adjacent pixels and then
6 comparing the calculated profile value with a
7 predetermined value.

1 21. A halftoning method according to claim 13,
2 wherein said profile discriminating is carried out by
3 calculating a profile value of the noteworthy pixel
4 based on both the multilevel value of the noteworthy
5 pixel and those of the adjacent pixels and then
6 comparing the calculated profile value with a
7 predetermined value.

1 22. A halftoning method according to claim 20,
2 wherein a two-dimensional digital filter dedicated to
3 profile enhancement is used in said calculating of the
4 profile value.

1 23. A halftoning method according to claim 21,
2 wherein a two-dimensional digital filter dedicated to
3 profile enhancement is used in said calculating of the
4 profile value.

1 24. A halftoning method according to claim 22,
2 wherein said two-dimensional digital filter dedicated
3 to profile enhancement is a Laplacian filter.

1 25. A halftoning method according to claim 23,
2 wherein said two-dimensional digital filter dedicated
3 to profile enhancement is a Laplacian filter.

1 26. A halftoning method according to claim 22,
2 wherein said two-dimensional digital filter dedicated
3 to profile enhancement is a Prewitt filter.

1 27. A halftoning method according to claim 23,
2 wherein said two-dimensional digital filter dedicated
3 to profile enhancement is a Prewitt filter.

1 28. A halftoning method according to claim 20,
2 wherein the profile value is directly calculated by
3 making addition and subtraction individually on the
4 multilevel values of the noteworthy pixel and the
5 adjacent pixels.

1 29. A halftoning method according to claim 21,
2 wherein the profile value is directly calculated by
3 making addition and subtraction individually on the
4 multilevel values of the noteworthy pixel and the
5 adjacent pixels.

1 30. A halftoning method according to claim 10,
2 wherein in said technique changing step (d), the error
3 diffusion technique is changed to another technique
4 that is selected in a predetermined order from various
5 different error diffusion techniques.

1 31. A halftoning method according to claim 11,
2 wherein in said technique changing step (d), the error
3 diffusion technique is changed to another technique
4 that is selected in a predetermined order from various
5 different error diffusion techniques.

1 32. A halftoning method according to claim 10,
2 wherein in said technique changing step (d), the error
3 diffusion technique is changed to another technique
4 that is selected at random from various different error
5 diffusion techniques.

1 33. A halftoning method according to claim 11,
2 wherein in said technique changing step (d), the error
3 diffusion technique is changed to another technique

4 that is selected at random from various different error
5 diffusion techniques.

1 34. A halftoning method according to claim 10,
2 wherein

3 in said error diffusing step (c), the error
4 diffusion technique is a technique of proportionally
5 distributing the occurred error to the plural unscanned
6 pixels adjacent to the noteworthy pixel in accordance
7 with a predetermined weighting pattern, and

8 in said technique changing step (d), the error
9 diffusion technique is changed by changing said
10 predetermined weighting pattern to another pattern.

1 35. A halftoning method according to claim 11,
2 wherein

3 in said error diffusing step (c), the error
4 diffusion technique is a technique of proportionally
5 distributing the occurred error to the plural unscanned
6 pixels adjacent to the noteworthy pixel in accordance
7 with a predetermined weighting pattern, and

8 in said technique changing step (d), the error
9 diffusion technique is changed by changing said
10 predetermined weighting pattern to another pattern.

1 36. A halftoning method according to claim 12,
2 wherein if a plurality of multilevel input images to

3 be halftoned have a substantially identical profile,
4 said discriminating is carried out for only one of the
5 plural multilevel input images, and the result of said
6 discriminating is used in halftoning the remaining
7 multilevel input images.

1 37. A halftoning method according to claim 13,
2 wherein if a plurality of multilevel input images to
3 be halftoned have a substantially identical profile,
4 said discriminating is carried out for only one of the
5 plural multilevel input images, and the result of said
6 discriminating is used in halftoning the remaining
7 multilevel input images.

1 38. A halftoning apparatus for converting a
2 multilevel input image into a binary image, comprising:
3 an estimating section for calculating the
4 multilevel value of a given noteworthy pixel of the
5 multilevel input image, as an estimated value of the
6 noteworthy pixel, based on the multilevel values of
7 pixels other than the noteworthy pixel; and
8 a binarizing section for converting the estimated
9 multilevel value of the noteworthy pixel into a binary
10 value.

1 39. A computer-readable recording medium in
2 which a halftoning program for instructing a computer

3 to execute a function of converting a multilevel input
4 image into a binary image is recorded, wherein said
5 halftoning program instructs the computer to function
6 as the following:

7 an estimating section for calculating the
8 multilevel value of a given noteworthy pixel of the
9 multilevel input image, as an estimated value of the
10 noteworthy pixel, based on the multilevel values of
11 pixels other than the noteworthy pixel; and

12 a binarizing section for converting the estimated
13 multilevel value of the noteworthy pixel into a binary
14 value.